

WHAT IS CLAIMED IS:

- 1 An organosiloxane copolymer film having plural kinds of organosiloxane as composition unit,
  - 5 wherein the composition unit derived from the plural kinds of organosiloxane comprises at least both of a first organosiloxane with cyclosiloxane backbone and a second organosiloxane with straight-chain siloxane backbone; and
    - 10 wherein the organosiloxane copolymer film forms a bridge structure by bonding a plurality of second organicsiloxanes to the first organosiloxane.
- 2 An organosiloxane copolymer film according to claim 1, wherein the copolymer film has a film configuration in which a content ratio of the composition unit derived from the first organosiloxane with cyclosiloxane backbone and the composition unit derived from the second organosiloxane with straight-chain siloxane backbone is changing in the film thickness direction.
  - 20 3 An organosiloxane copolymer film according to claim 2, wherein the copolymer film is configured so that upper and lower planes of the copolymer film in the thickness direction are both contacting an inorganic insulation film,
    - 25 wherein, regarding the content ratio of the composition unit derived from the first organosiloxane and the composition unit derived from the second organosiloxane, the content ratio of the second organosiloxane with straight-chain siloxane backbone is higher in the vicinity of an interface with the inorganic insulation film at both the upper plane and lower plane, on the contrary, the content ratio of the second organosiloxane is lower at 30 an inner portion of the copolymer film compared with the content ratio in the vicinity of the interface; and,
      - 35 wherein a density of the copolymer film in the vicinity of the interface is larger than a density of the inner portion of the copolymer film.
- 4 A semiconductor device comprising an interlayer insulation film consisting of an organosiloxane film,

- wherein, the organosiloxane film is an organosiloxane copolymer film having plural kinds of organosiloxane as composition unit;
- wherein, the composition unit derived from the plural kinds of organosiloxane comprises at least both of a first organosiloxane with cyclosiloxane backbone and a second organosiloxane with straight-chain siloxane backbone;
- 5 wherein, a bridge structure is formed by bonding a plurality of second organosiloxanes to the first organosiloxane;
- wherein, the organosiloxane copolymer film is sandwiched by 10 inorganic insulators;
- wherein, regarding a content ratio of the composition unit derived from a first organosiloxane and the composition unit derived from a second organosiloxane, the content ratio of the second organosiloxane with straight-chain siloxane backbone is higher in the vicinity of an interface 15 with an inorganic insulation film at both upper and lower planes, on the contrary, the content ratio of the second organosiloxane is lower at an inner portion of the copolymer film compared with the content ratio in the vicinity of the interface; and
- wherein, a wiring layer is formed within the organosiloxane 20 copolymer film embedding a copper film therein.

- 5 A vapor deposition method for depositing an organosiloxane copolymer film having plural kinds of organosiloxane as composition unit on a substrate, wherein the organosiloxane copolymer film comprising at least 25 both of a first organosiloxane with cyclosiloxane backbone and a second organosiloxane with straight-chain siloxane backbone as the composition unit derived from the plural kinds of organosiloxane, and wherein the organosiloxane copolymer film forms a bridge structure by bonding a plurality of second organicsiloxanes to the first organosiloxane,
- 30 wherein the method comprising, steps of:
  - vaporizing a first organosiloxane monomer with cyclosiloxane backbone;
  - vaporizing a second organosiloxane monomer with straight-chain siloxane backbone;
- 35 supplying a vaporized first organosiloxane monomer gas at a predetermined supply rate;

supplying a vaporized second organosiloxane monomer gas at a predetermined supply rate;

forming a mixed gas by mixing the supplied first organosiloxane monomer gas and the supplied second organosiloxane monomer gas;

5 introducing the mixed gas in a reaction chamber under reduced pressure; and

spraying the introduced mixed gas onto a heated substrate after passing through a plasma atmosphere generated in the reaction chamber, wherein, the vapor deposition method grows a copolymer film forming a 10 bridge structure by reacting the first organosiloxane monomer and the second organosiloxane monomer in the mixed gas sprayed onto the substrate, and thereby bonding a plurality of second organosiloxanes to the first organosiloxane.

15 6 A vapor deposition method according to claim 5, wherein a supply rate ratio of the first organosiloxane monomer gas and the second organosiloxane monomer gas is changed by changing supply rates of the first organosiloxane monomer gas and the second organosiloxane monomer gas respectively, and thereby response to a change of the supply rate ratio, a 20 content ratio of the unit derived from the first organosiloxane with cyclosiloxane backbone and the unit derived from the second organosiloxane with straight-chain siloxane backbone is changing in the film thickness direction.

25 7 A vapor deposition apparatus for depositing an organosiloxane copolymer film having a plurality of organosiloxanes as composition units, at least comprising:

30 a plurality of monomer gas supplying units for individually supplying a plurality of organosiloxane monomer gases by controlling each of supplying rate;

a unit for mixing a plurality of organosiloxane monomer gases supplied from the plurality of monomer gas supplying units;

35 a reaction chamber equipped with a substrate heating member capable of loading a substrate, and a shower head capable of spraying a mixed gas uniformly onto a surface of the substrate loaded on the substrate heating member;

- an RF power supply connected to the shower head for supplying an RF voltage to the shower head, in respect to the earthed heating member; and
- an evacuation apparatus for reducing a pressure in the reaction chamber,

5 wherein the plurality of monomer gas supplying units comprises at least a first monomer supplying unit for vaporizing and supplying a first organosiloxane with cyclosiloxane backbone, and a second monomer supplying unit for vaporizing and supplying a second organosiloxane with 10 straight-chain siloxane backbone.

8 A vapor deposition apparatus according to claim 7, further comprising a cleaning gas supplying unit,

15 wherein the unit for mixing the plurality of monomer gases mixes a cleaning gas supplied from the cleaning gas supplying unit into the plurality of monomer gases.